Detail synthesis on terrain models using aerial images

Oscar Argudo
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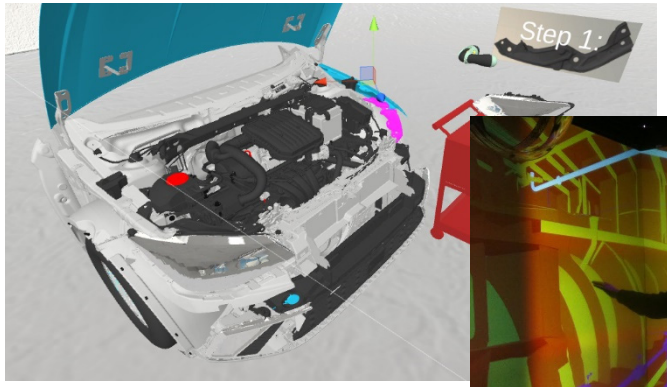
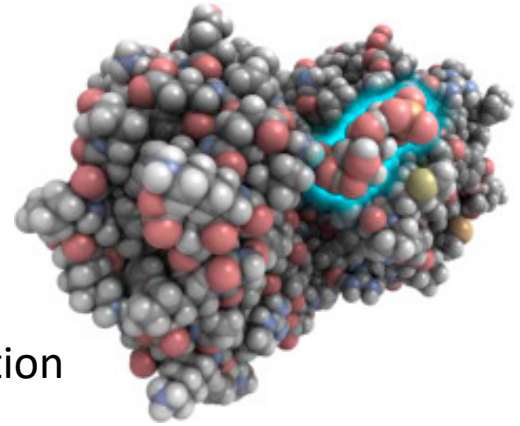
ViRVIG research group

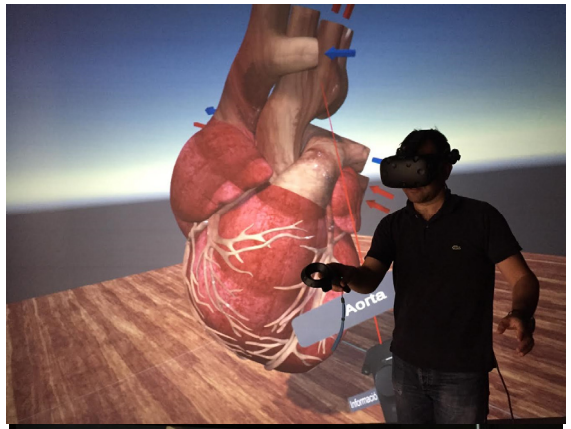


VR for industrial assemblies

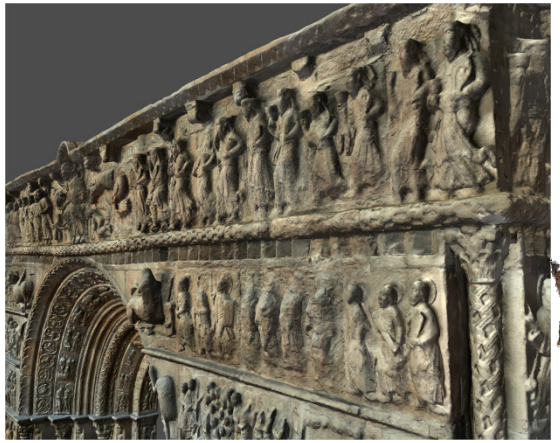


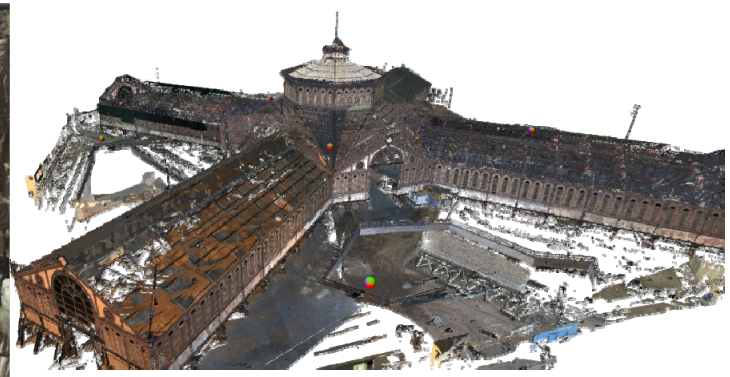
scientific visualization

crowd simulation



medical VR





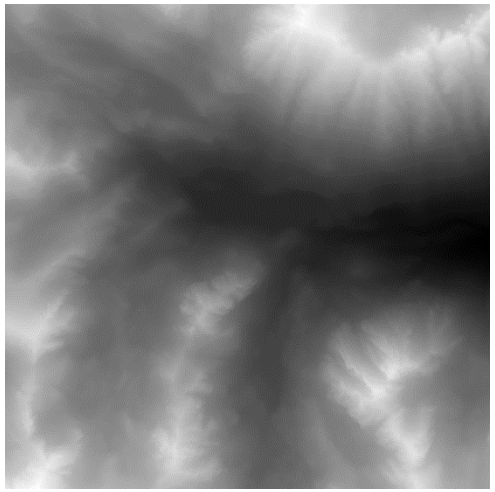
virtual heritage & scans

...

urban models

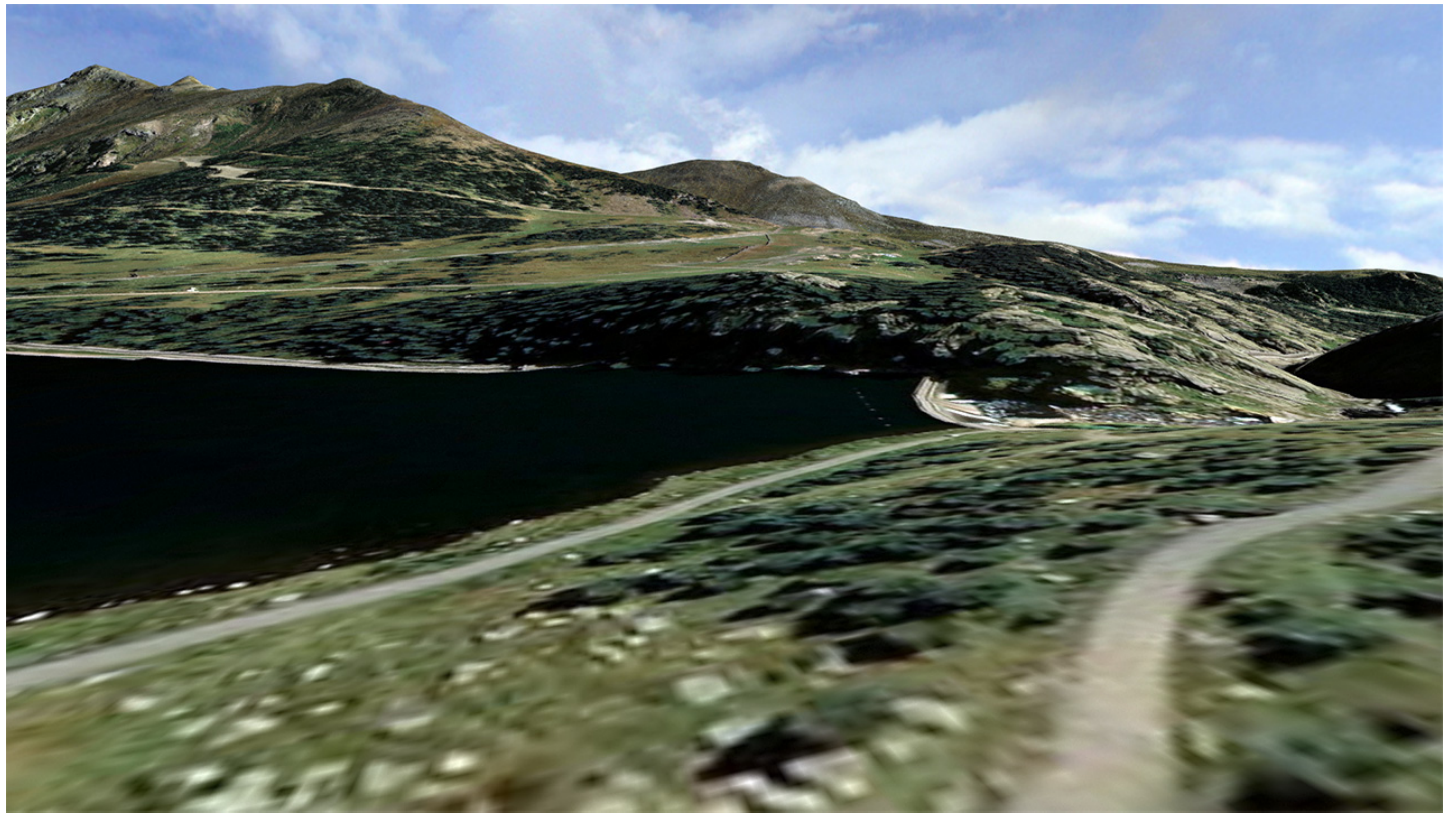
My thesis

- Generation of highly detailed realistic terrain models from public data



elevation map

aerial image



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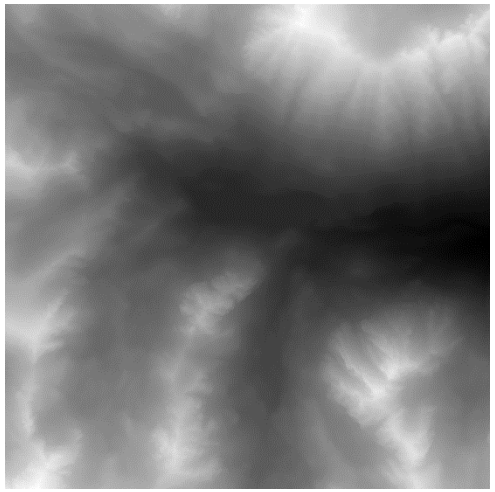

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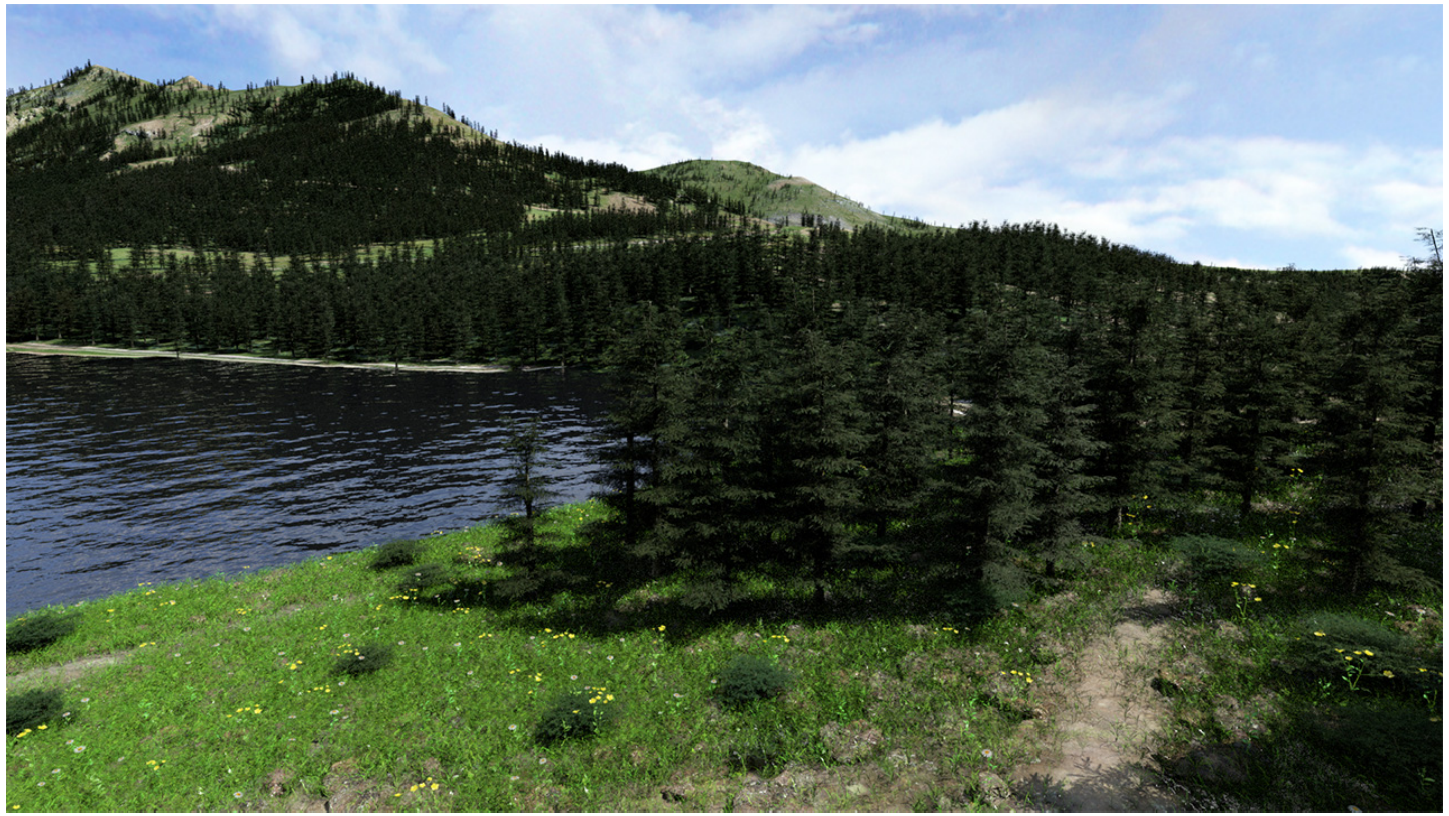
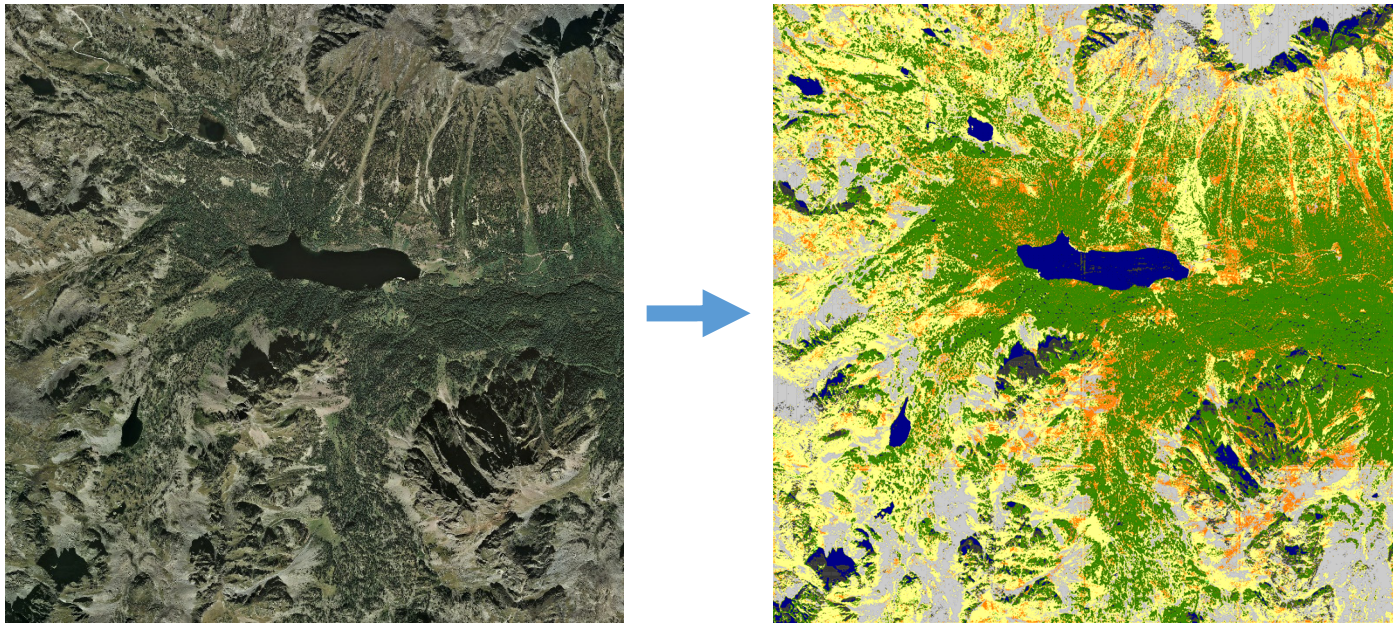


Thesis topics

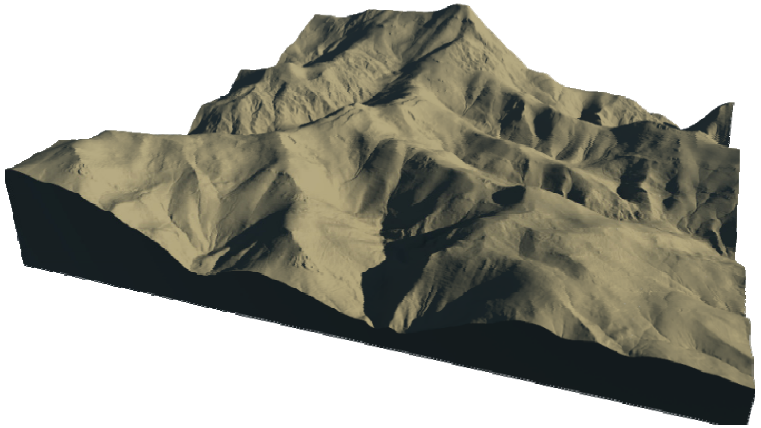
- Aerial image segmentation

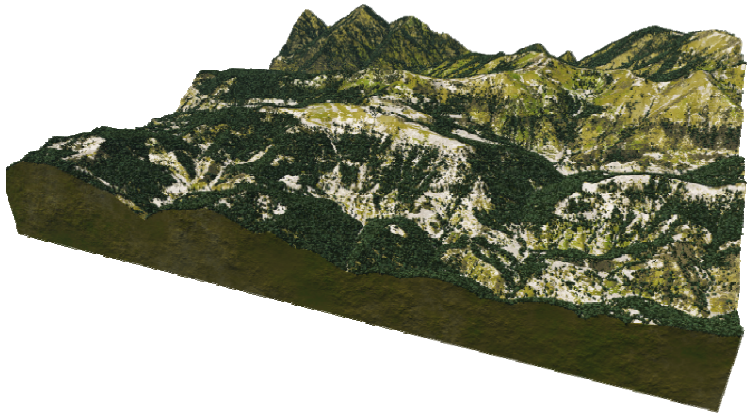


O. Argudo, M. Comino, A. Chica, C. Andújar, and F. Lumbreras. *Segmentation of Aerial Images for Plausible Detail Synthesis.* Computers & Graphics 71 (2018), pp. 23-34.

Thesis topics

- Aerial image segmentation
- New information layers based on examples





O. Argudo, C. Andújar, A. Chica, E. Guérin, J. Digne, A. Peytavie, and E. Galin. *Coherent multi-layer landscape synthesis*. The Visual Computer 33.6 (2017), pp. 1005-1015.

Thesis topics

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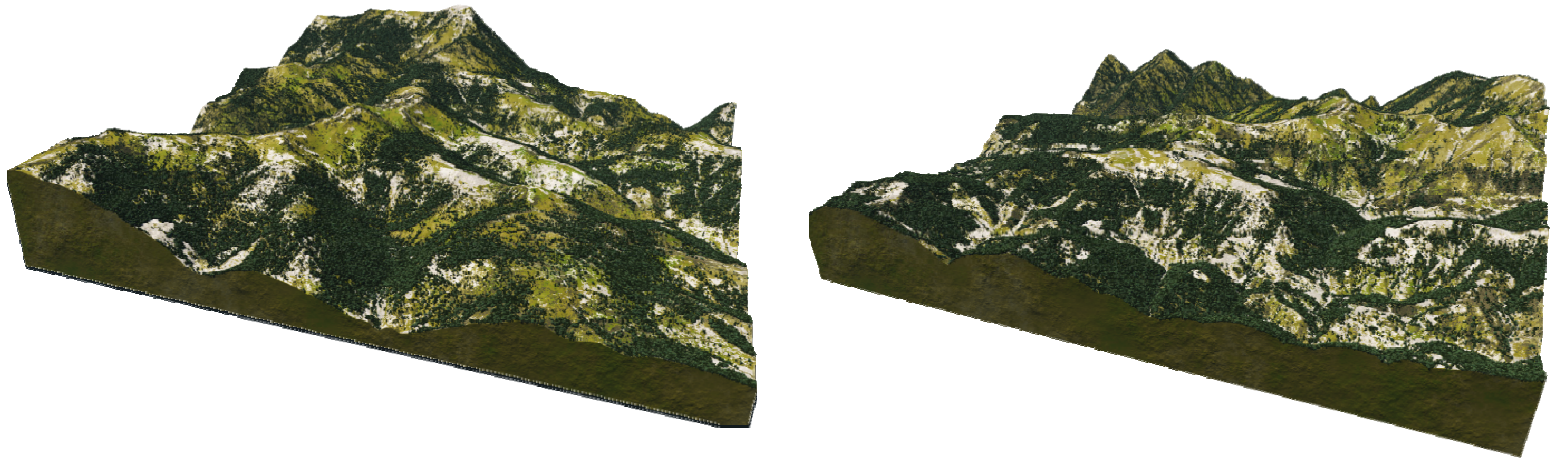
- New information layers based on examples



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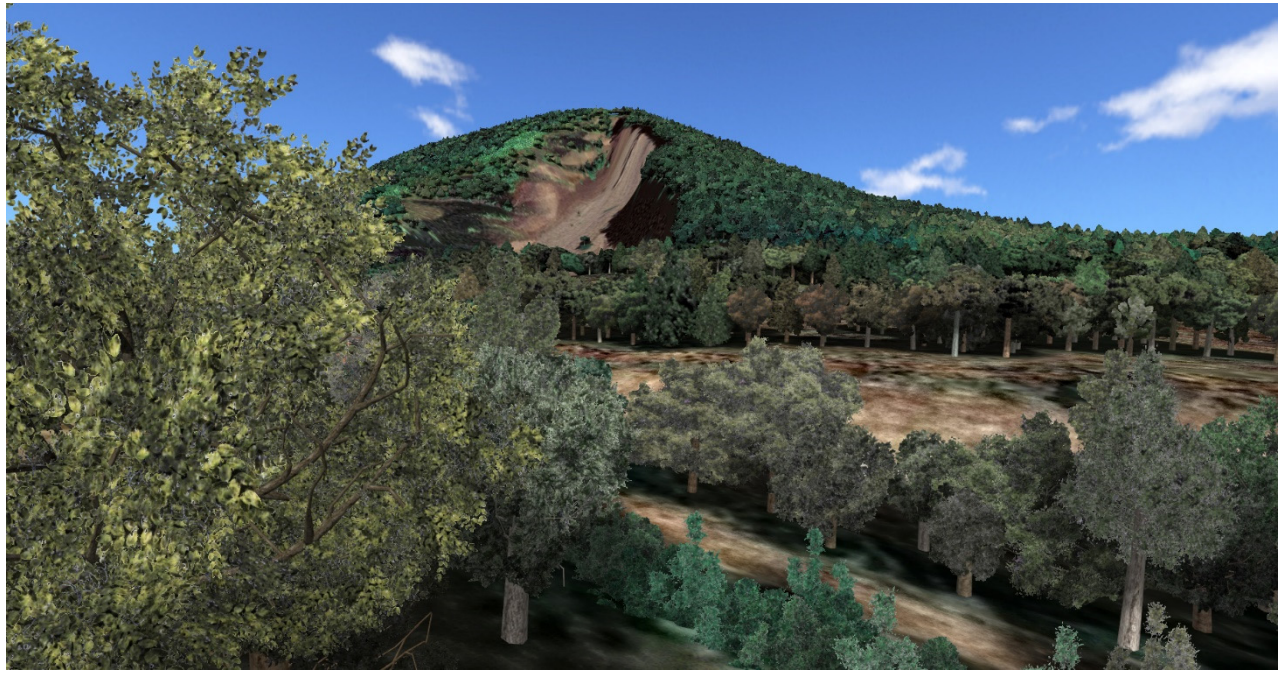
Thesis topics

- Aerial image segmentation
- New information layers based on examples
- Vegetation modeling and rendering



O. Argudo, A. Chica, and C. Andújar. *Single-picture reconstruction and rendering of trees for plausible vegetation synthesis*. Computers & Graphics 57 (2016), pp. 55-67.

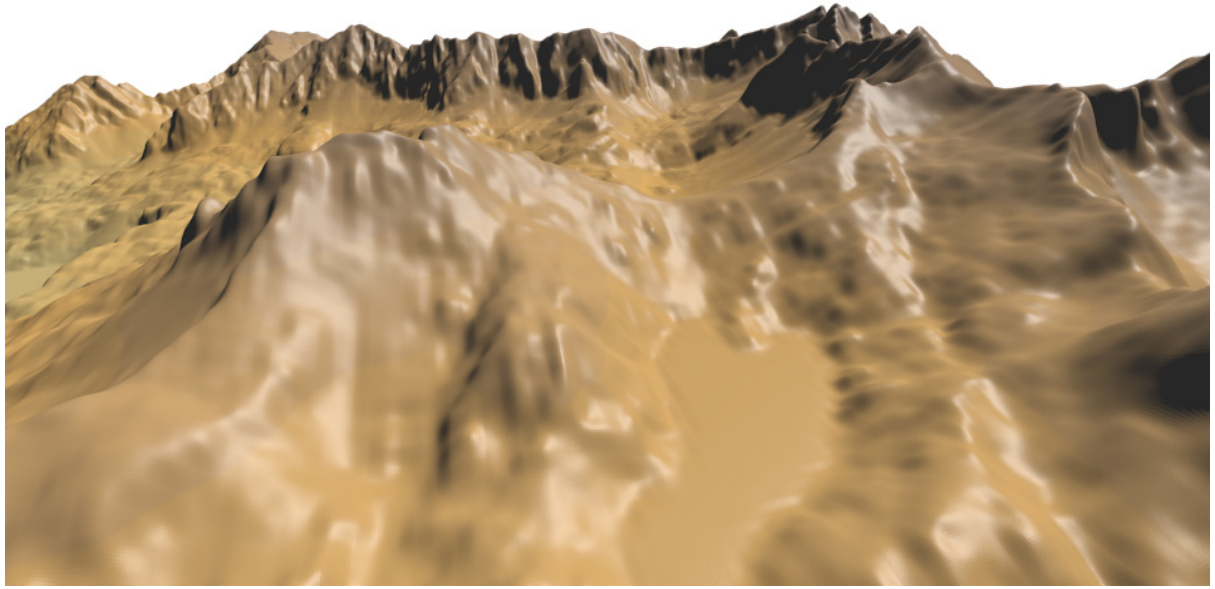
O. Argudo, C. Andújar, and A. Chica. *Tree Variations*. In CEIG - Spanish Computer Graphics Conference. 2017.

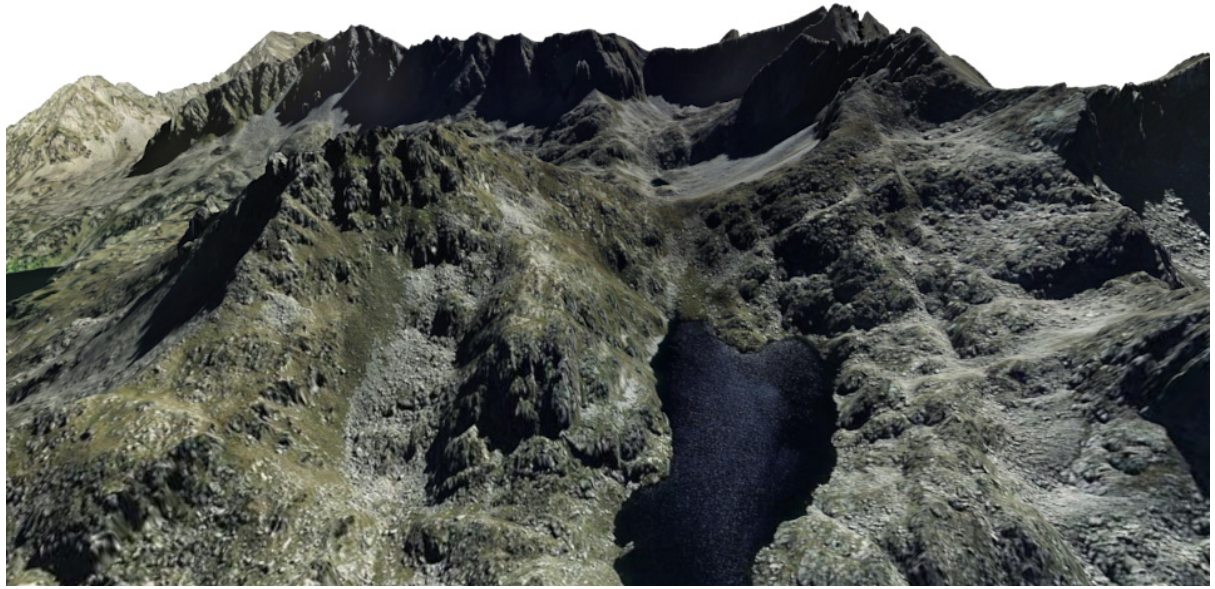
Thesis topics

- Aerial image segmentation
- New information layers based on examples
- Vegetation modeling and rendering
- **DEM enhancement**

Terrain super-resolution through aerial imagery

- DEM resolutions are usually 10-30 m/pixel
- Aerial imagery resolution 1 m/pixel or better (e.g. Catalunya: 10-25 cm/pixel)





O. Argudo, A. Chica, and C. Andújar. *Terrain Super-resolution through Aerial Imagery and Fully Convolutional Networks.* Computer Graphics Forum 37.2 (2018), pp. 101-110.

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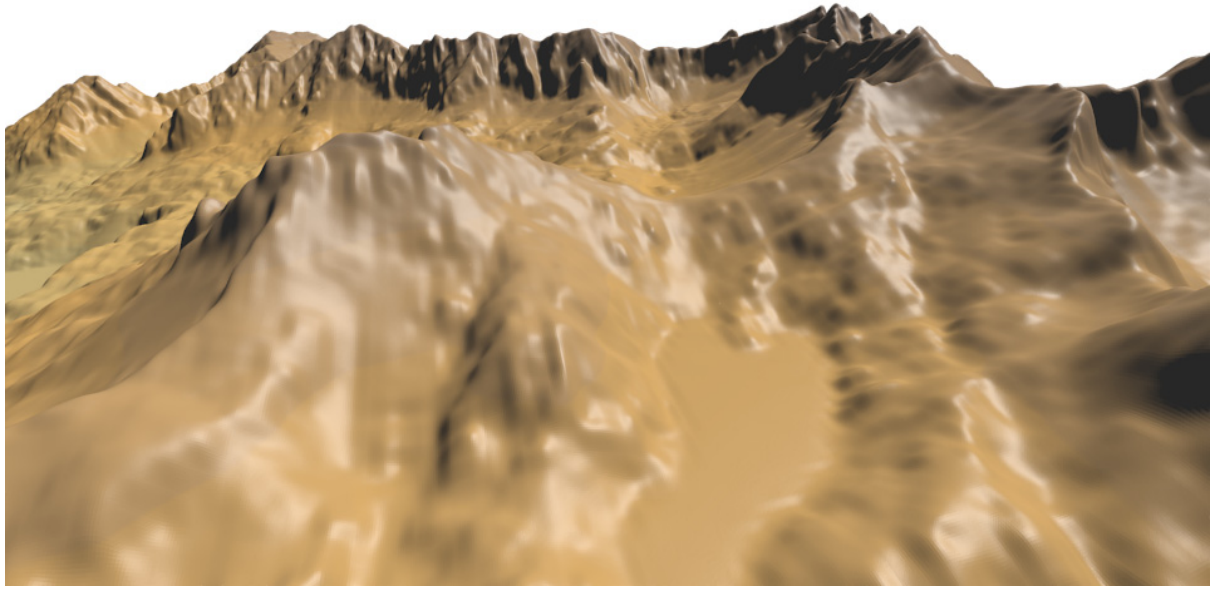
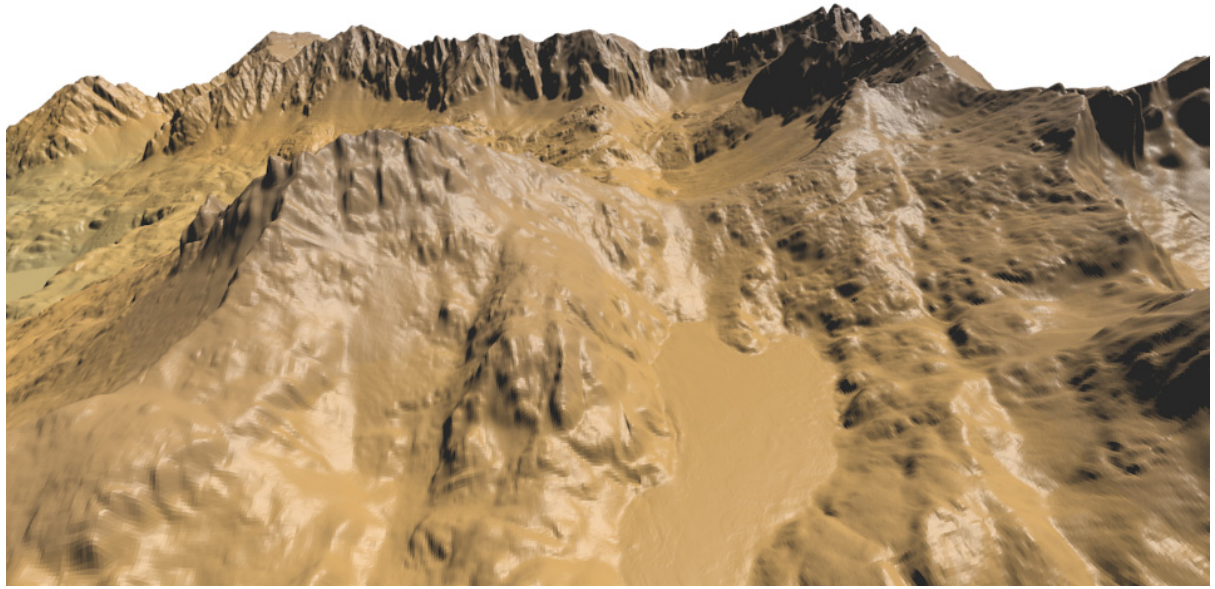
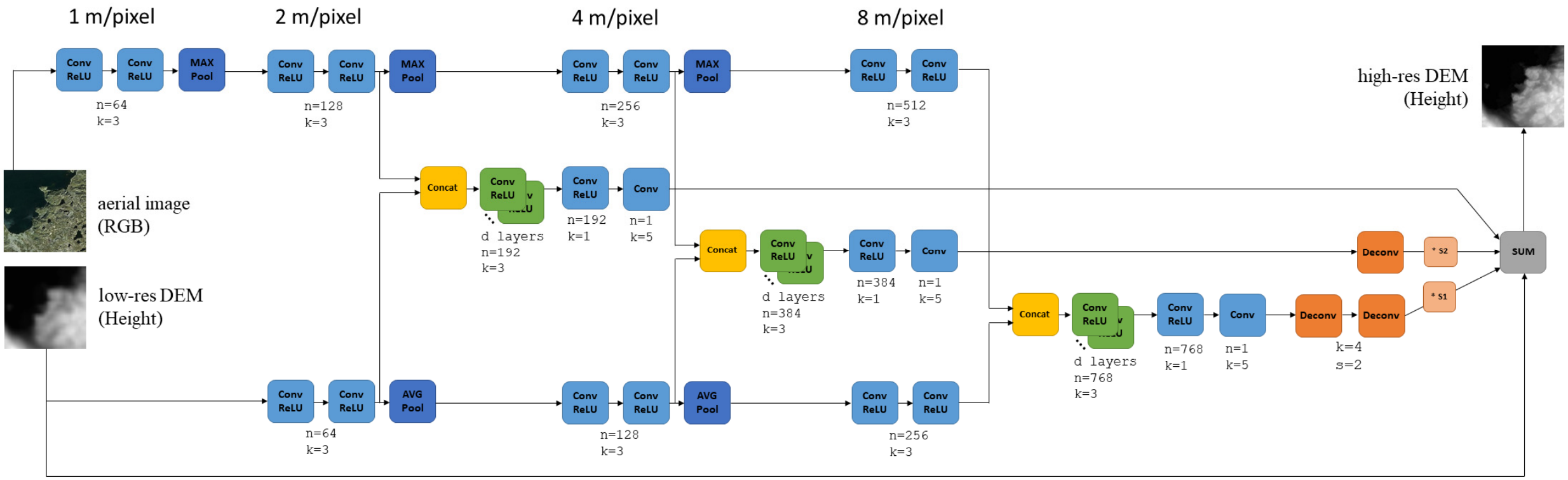


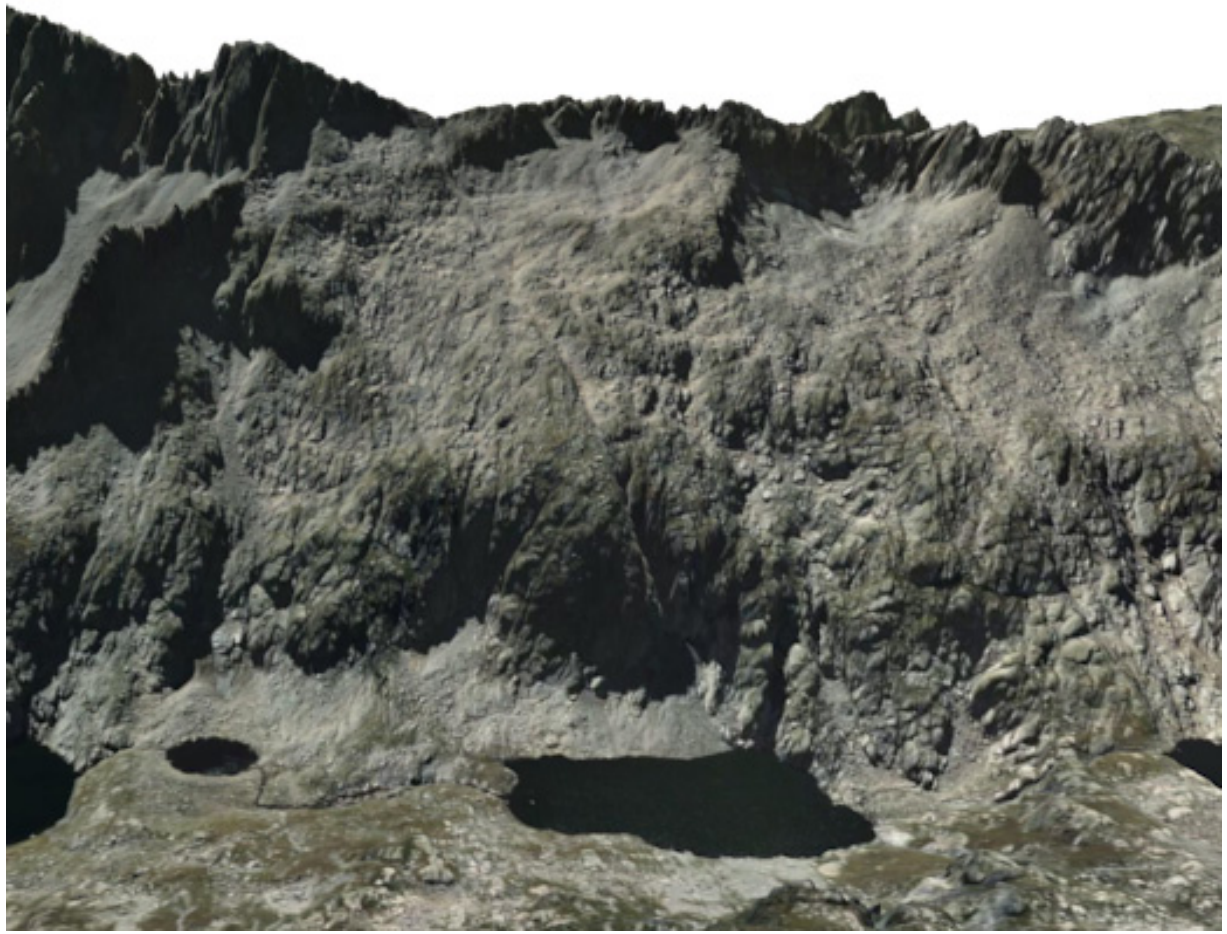


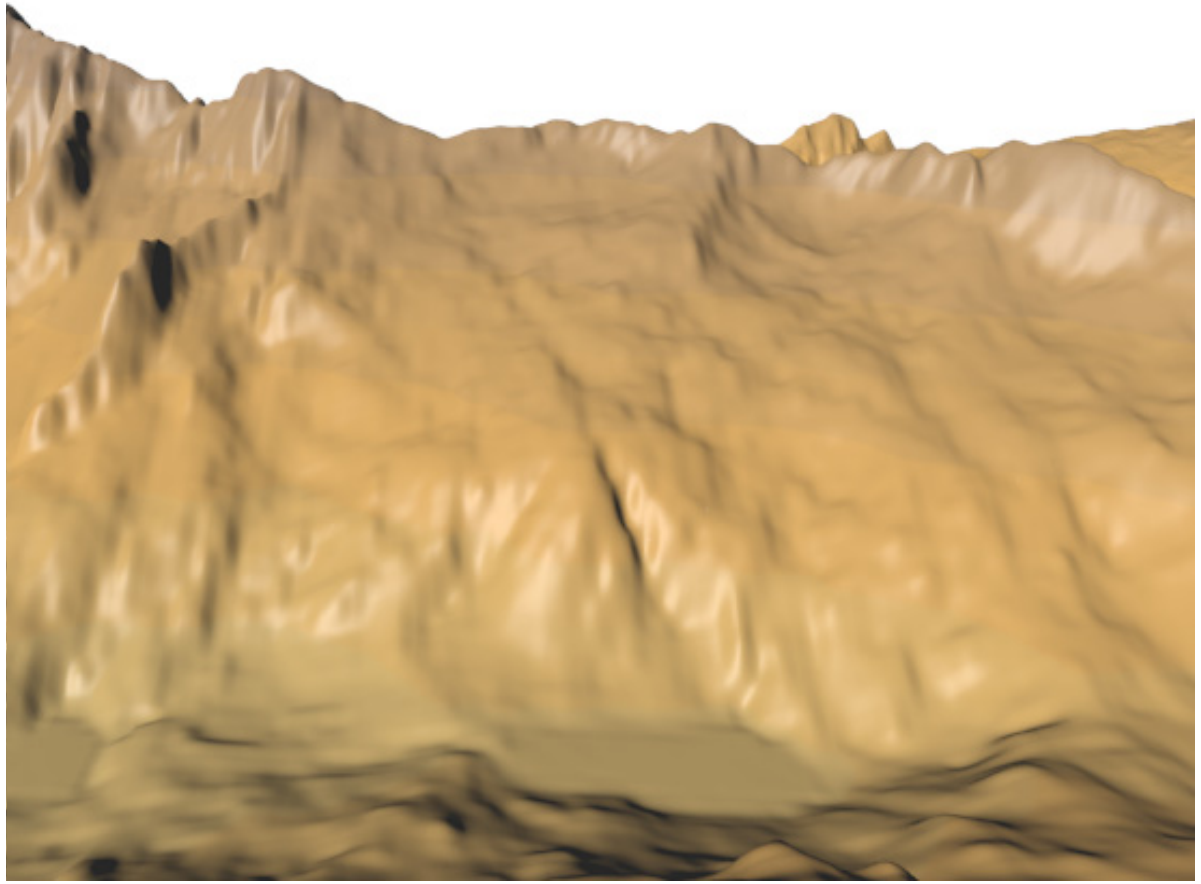
O. Argudo, A. Chica, and C. Andújar. *Terrain Super-resolution through Aerial Imagery and Fully Convolutional Networks.* Computer Graphics Forum 37.2 (2018), pp. 101-110.

DEM + photo Fully Convolutional Network

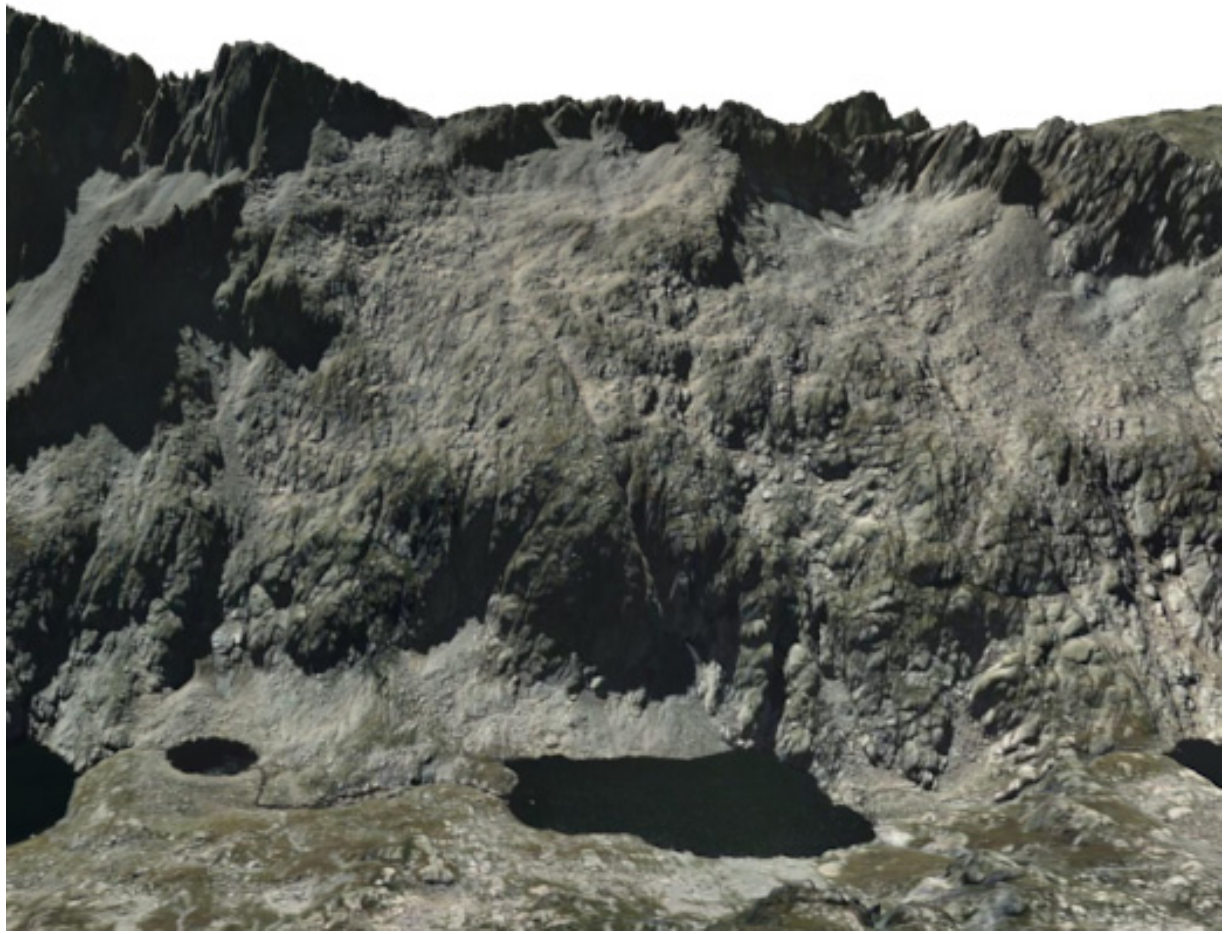


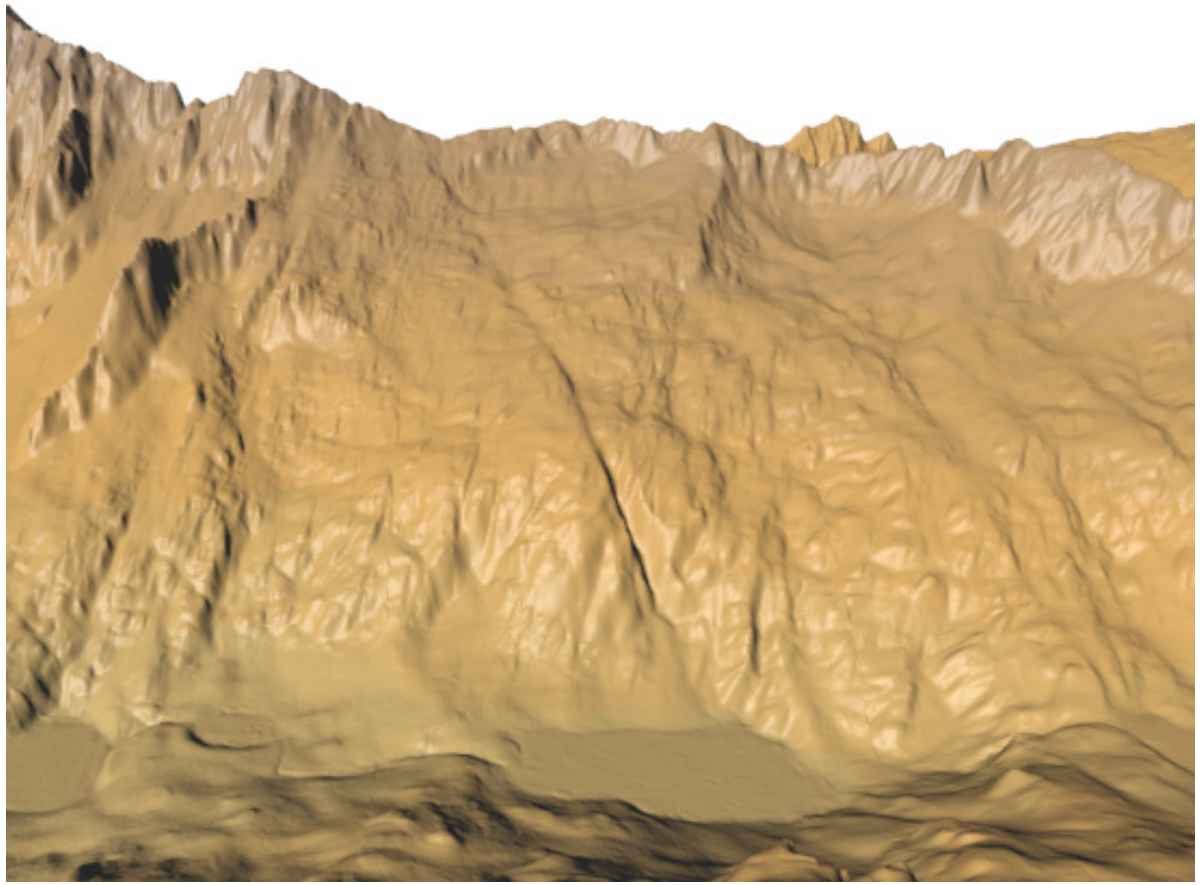
Visual results



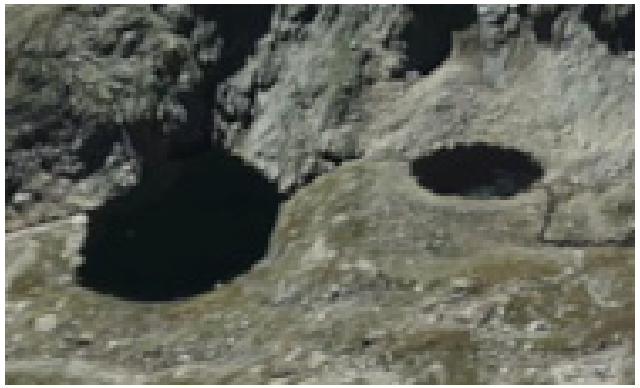


Visual results

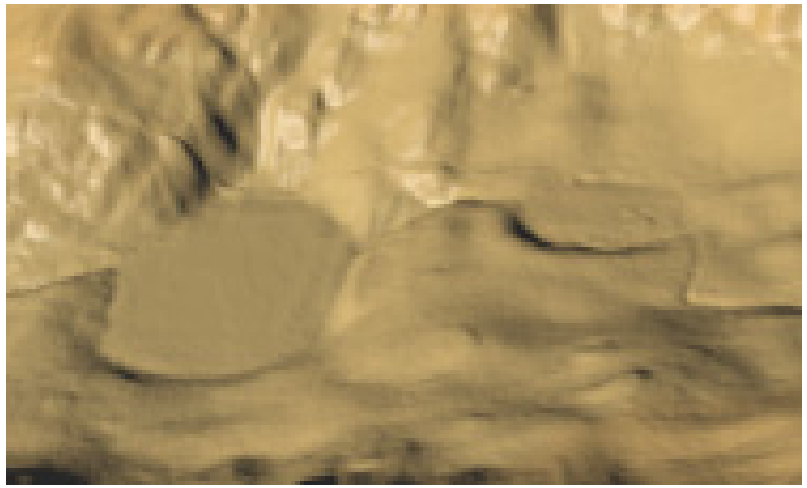




Visual results



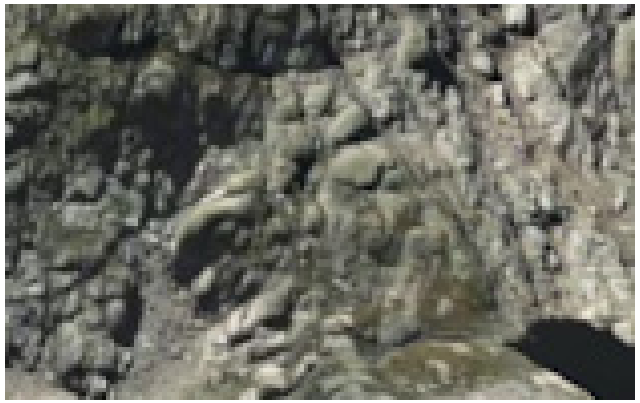
DEM 15m

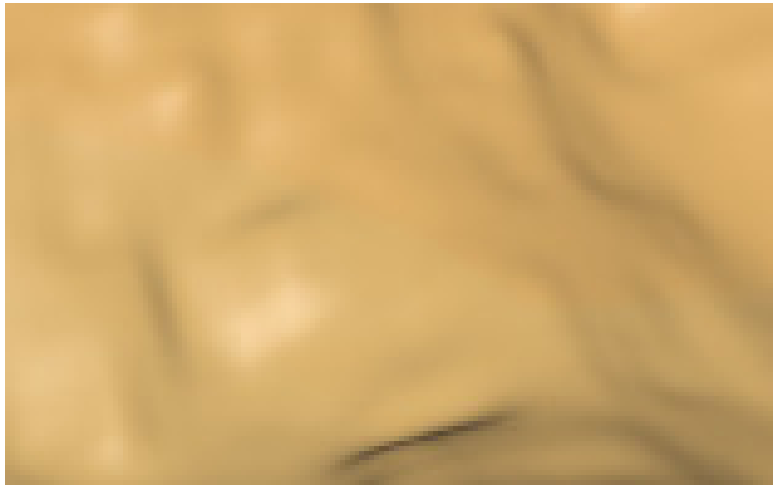


net output

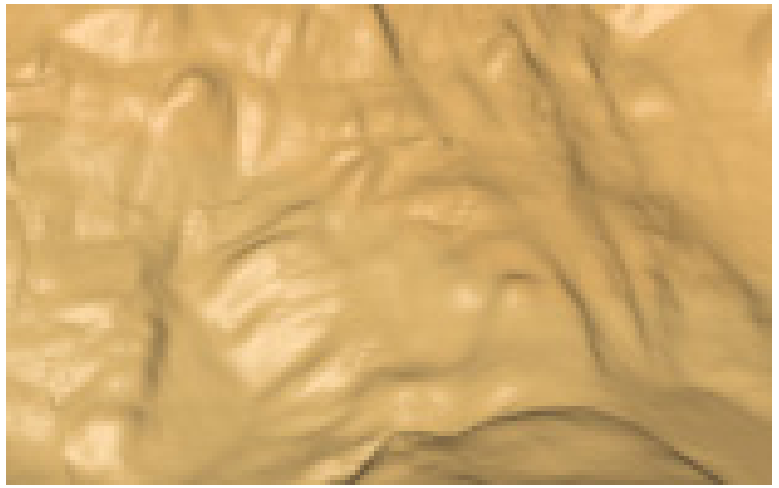
DEM 2m

Visual results

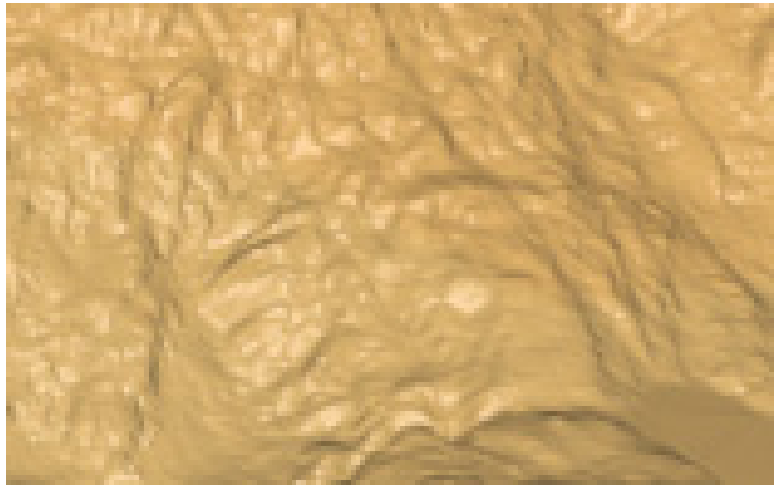




DEM 15m



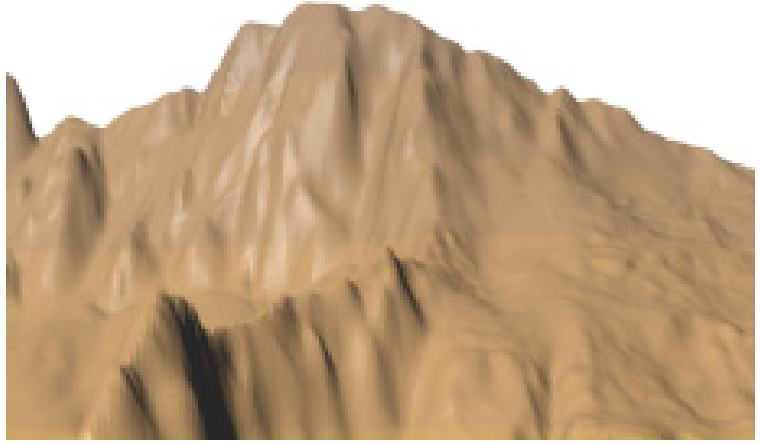
net output



DEM 2m

Visual results

DEM 15m



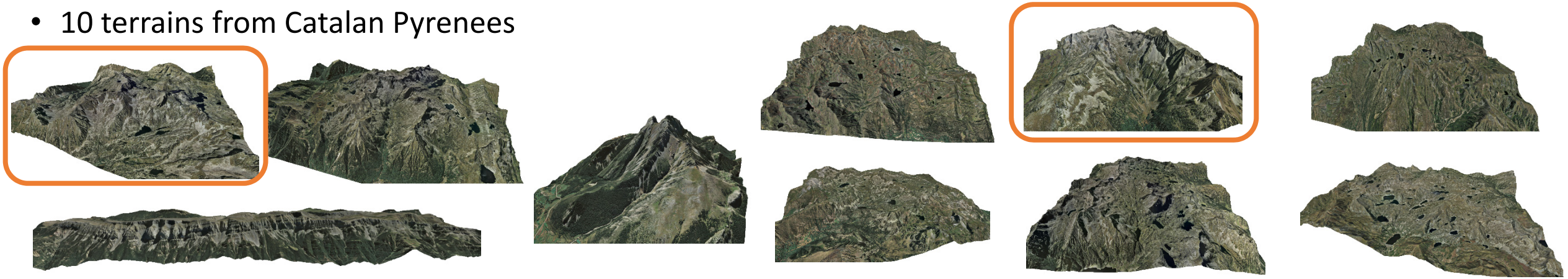
net output

DEM 2m

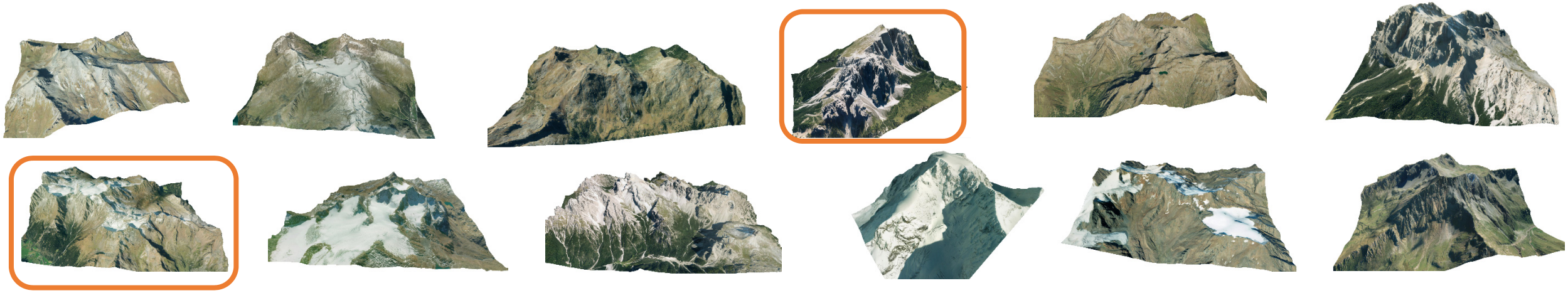
Does the net generalize?

Terrains excluded from training and validation

- 10 terrains from Catalan Pyrenees

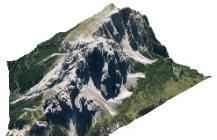


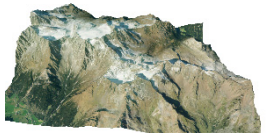
- 12 terrains from South Tyrol



Does the net generalize?

- We trained 3 networks: only with Pyrenees, only with Tyrol, and both
- Measured RMSE w.r.t. 2m DEM on two terrains from each set





RMSE (m)	Bilinear up	Bicubic up	Net (Pyrenees)	Net (Tyrol)	Net (Both)
Pyrenees Test 1 (Bassiero)	1.662	1.406	1.013	1.125	1.005
Pyrenees Test 2 (Forcanada)	1.905	1.632	1.101	1.266	1.097
Tyrol Test 1 (Dürrenstein)	1.948	1.445	1.122	0.941	0.901
Tyrol Test 2 (Monte Magro)	1.220	0.917	0.708	0.600	0.587

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